



DISTRIBUTION OF QUALITY INDEX OF GROUNDWATER AROUND SELECTED WASTE DUMPSITES IN RIVERS STATE

EDWARD, LAWSON¹, UGWOHA, EJKEME² & OFILI, METHADIUS, I.³

^{1, 2 and 3}; Centre for Occupational Health, Safety and Environment, Institute of Petroleum Studies,
Faculty of Engineering, University of Port Harcourt, Rivers State, Nigeria

². Department of Civil and Environmental Engineering, University of Port Harcourt, Rivers State,

Lead Author's Email; edwardlawson555@gmail.com

Corresponding Author's Email: ugwujaeji@gmail.com

Abstract

This paper assessed the distribution of quality index of groundwater around selected waste dumpsites in Rivers State. Three waste dumpsites in Aluu, Eneka and Trans-amadi communities in River state were randomly sampled. Groundwater sourced from boreholes sited at distances of 100m, 150m and 200m away from the dumpsites were sampled for the study in November and analyzed in laboratory for some water quality parameters (physicochemical properties are pH, BOD, COD, TDS, EC and Turbidity, while heavy metals are Copper, Nickel, Lead, Cadmium, Chromium, Iron and Zinc). The results of the analysis revealed that; some of the selected water quality parameters were within the accepted WHO standards in the three communities while some parameters are not within accepted standards especially Lead which is higher than accepted standard at 100m and 150m away from the waste dumpsite in the three communities, Water quality index (WQI = 0.87) for water sample obtained at distances of 100m away from the waste dumpsite in Aluu was not good for drinking, while WQI of 0.71 and 0.63 for sample obtain at 150 and 200m respectively were poor, therefore, need minor treatment before drinking , WQI for water sampled from Eneka at distances of 100m and 150m away from dumpsite were not for drinking (WQI = 1.05 and 0.87) while the water sampled from 2000m was good for drinking (WQI = 0.46) while for Trans-amadi, the water sampled at distances of 100m and 150m are not good for drinking (WQI = 1.01 and 0.96) while water sampled at 200m is poor therefore, need minor treatment before drinking (WQI = 0.73).. It was concluded that groundwater system close to waste dumpsites in Rivers State are polluted.

Keywords:

Water Quality Index, Groundwater, Waste Dumpsites, Rivers State

1. INTRODUCTION

Groundwater is the water present beneath Earth's surface in rock and soil pore spaces and in the fractures of rock formations. About 30 percent of all readily available freshwater in the world is groundwater. Groundwater is a major part of the natural water cycle. Some part of the precipitation that lands on the ground surface infiltrates into the subsurface (Famiglietti.2024). Groundwater is recharged from the surface; it may discharge from the surface naturally as springs and seeps, and can

form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal, and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is known as hydrogeology, also called groundwater hydrology (Famiglietti, 2024).

Waste generated due to increased human activities occasioned by rapid growth in population has caused the increased demand for land to dump refuse which is not followed up with adequate waste treatment procedure and management facilities thereby resulting in the contamination and pollution of the groundwater arising from leaching potentials of the soil. The unwholesome practices by individuals, corporate bodies, industries and factories introduces wastes and chemicals into the ecosystem. This action can be by accidental or intentional discharge and the nature of the soil has also allowed these chemicals and wastes to leach through it to the water underground which could be dangerous to human. The difficulty in the remediation of the contaminated groundwater and the financial burden required to restore it to the actual/normal state calls for concern (Nwoke & Etori, 2020).

The groundwater contamination by chemical species such as heavy metals, nitrates, fluorides, microorganisms etc. can affect the health status of humans who is the ultimate user of the water. These chemical species find their way into the water aquifer through leaching. Such human activities that introduce these unwanted species to the groundwater are processing of metals, exploration, production and eventual exploitation of oil, agricultural activities, mining and through indiscriminate disposal of the byproducts of these human activities have added to the already overburdened situation (Adeyemi & Awokunmi, 2016; Etori et al., 2019). The manner in which the inhabitants of a particular area dispose wastes can also contribute to the level of contamination of the groundwater. The groundwater can be easily polluted through wastes, sewage and effluents that originates from homes, industries and commercial centers through percolation into the groundwater.

Groundwater has various advantages over surface water as it is not exposed to water pollutants associated with surface waters. It is in view of this that the WHO recommended that drinking water supplies should be well analyzed based on their contamination or pollution level. Very few people in small towns have access to safe water supply. Only about 5 percent get water from protected ground sources through boreholes (Bunce, 2014). The WHO had stated that it is not sufficient merely to have access to water in adequate quantities, the water also needed to be of adequate quality to maintain good health (WHO, 2017). Such water must be free from toxic biological, physical and chemical contaminations. The widespread reports on pollutants in groundwater have increased in recent years and have resulted in increased public concern about the quality of groundwater. The importance of potable water, both for domestic and industrial uses, has created concern for water quality analysis (Bunce, 2014). The compounds contained in groundwater, sometimes used as drinking water, are dangerous to human health because of the possibility of a mutagenic and carcinogenic reaction (Owabor et al., 2010).

Groundwater bodies are prone to contamination from both anthropogenic and natural activities (Umo & Okoye 2017). Boreholes, though more protected as a result of inherent chemical constituents of permeable rocks through which the water flows, can limit the quality of the water as they may have dissolved impurities which came from rock and sand strata through which the water flowed or passed. The seepage of waste

buried underground such as pit dump sites, pit toilets or leachate from fertilizer applications and debris from erosion can produce harmful effects on groundwater quality especially in groundwater reserve close to the pit dumpsites and pit toilets. This problem of gradual seepage of waste water into the groundwater system poses the problem of gradual contamination of groundwater especially in groundwater system close to underground dumpsites. Hence, this present study was carried out to assess the distribution of pollutant mainly heavy metals and other physicochemical parameters) in groundwater samples close to selected waste dump sites in Rivers State. The study is mainly focused on investigating the safe level of water samples from boreholes close to dump sites focusing on concentration of selected heavy metals and some physicochemical properties of the groundwater waters.

River State being the hob of industrial activities in Niger-delta due to presence of several chemical and petrochemical firms with the potentials of generating solid wastes capable of producing leachate that can contaminate the groundwater system around waste dumpsites. Therefore, substances contained in groundwater, sometimes used as drinking water, especially around waste dumpsites could be dangerous to human health because of their possible mutagenic and carcinogenic reaction. Therefore, there is need to investigate the quality index of Groundwater systems around waste dumpsites especially in River's state with massive activities of chemical and petrochemical firms with potentials of generating harmful solid waste that can be easily dumped in open dump pits around the state

2 MATERIAL AND METHODS

2.1 Research Design

This study adopted Experimental design. The design is suitable for this study because it involves carrying out empirical study in which the researcher has room to control and manipulate the independent variable based on the limitations and scope of this study. In this study, the independent variables are distant of boreholes from dumpsite and time interval for the collection of water samples from boreholes while the dependent variable is the concentration of heavy metals in the water sample

2.2 Study Area

Ikwerre and Obioakpr local government area are among biggest local government areas in Rivers State in terms of population and revenue and generation. The LGAs are among of the 23 Local government areas Rivers State borders includes; Etche LGAs in the north, Port Harcourt court Eleme LGA in the Southern part Emuhua LGA in the western part and Oyibo LGA in the eastern part. The council capitals are Ishiokpo and Rumuodamaya respectively. The economy of these areas is dominated by the booming petroleum industry and some manufacturing companies. Although the rise of the oil industry has led to increased revenue for the state government, mismanagement and corruption have prevented the state from rapid development and meaningfully tackling poverty. The land surface of area just like other areas in Rivers State can be divided into three zones:

This study is focused on Eneka and Trans-amadi communities in Obioakpor LGA as well as Aluu community in Ikwerre LGA all in River state and see Figure 1. These study areas as well as the entire Rivers State, lies within the Niger Delta Sedimentary Basin. Lithostratigraphically, the rocks are divided into the oldest Akata Formation (Paleocene), the Agbada Formation (Eocene) and the Youngest Benin Formation

(Miocene to Recent) which hold the ground water aquifer in the area and the main subject of interest in this current study.

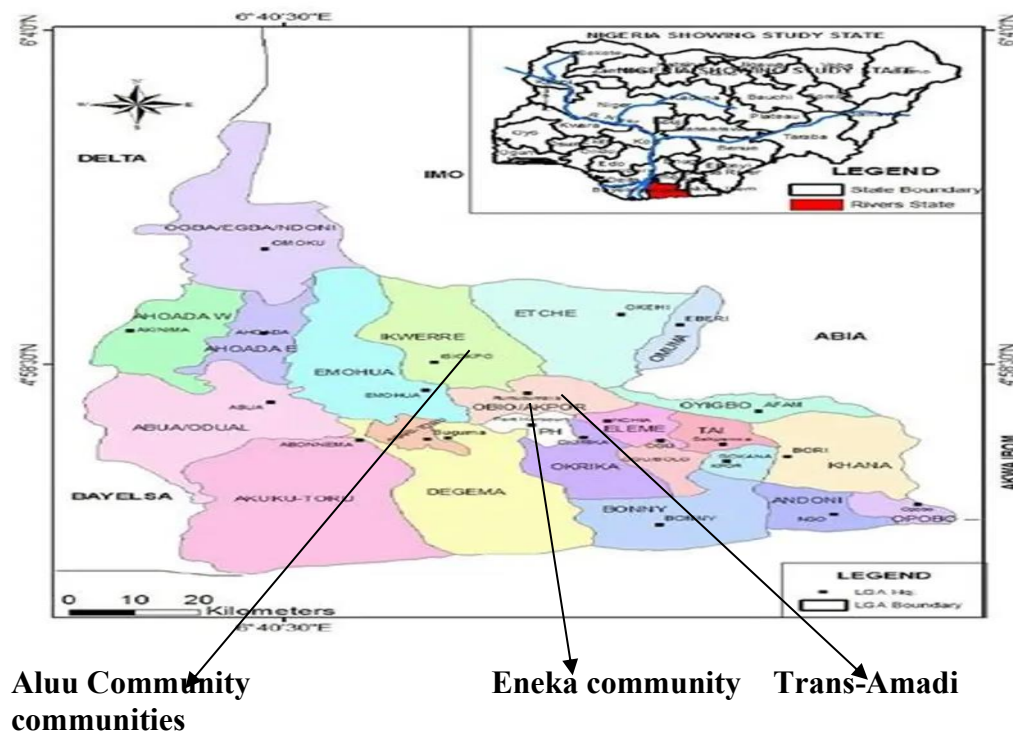


Figure 1 Map of Rivers State showing the Local government area

2.3 Type of Data

The data used in this study was a combination of primary and secondary data. The primary data were sourced from the study area which included data on the level of some physicochemical parameters and heavy metal in the water sample and data on the distance of the sampled boreholes from the dumpsites. The secondary data was mainly the data on standard for design and siting of waste dumpsite, and data on the permissible limit for different physicochemical parameters and heavy metal in water from (WHO, 2017).

2.4 Procedure for Data Collections

The procedure for the collection of water sample from around the three waste dumpsites are presented as follows

1. Three dumpsites (Dumpsites in Eneka and Transamadi Communities in Obioakpor LGA and Aluu Community in Ikwerre LGA) were sampled within River state and they were labeled Site 1 (S1), Site 2 (S2) and Site 3 (S3) respectively.
2. Residential boreholes were sampled at different distances of 100m, 150m and 200m away from the dumpsite site 1, 2 and 3 these boreholes were labelled EN1, EN2 and EN2 for Eneka Community, TA1, TA2 and TA3 for Transamadi community and AL1, AL2 and A13 for Aluu community
3. Geo-mapping procedures was used to ascertain the coordinate of the dumpsites and the residential boreholes sampled.

4. Groundwater samples were collected from the boreholes considering that there are three sampled boreholes in each sampled area, which makes nine water samples collected around the three sampled areas during the sampling month.
5. The groundwater samples were taken to laboratory for identification of presence and concentration of the heavy metals

2.5 Laboratory Analysis

The water and sediment samples will be transported to the Lab for the following analysis; The physicochemical properties of water sample that were analyzed are pH, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), total dissolved solids (TDS), Turbidity, and electrical conductivity (EC). The concentration of heavy metals (Fe, Ni, Pb, Cd, Cu, Cr, and Zn) in water samples was determined using atomic absorption spectrophotometry (Varian AA 240 AAS) (American Public Health Association (APHA) and American water works Association (ALPHA, 2012).

2.6 Procedure for identification of Presence and Concentration of the Heavy Metals in the water sample

The determination of presence and concentration of the heavy metal content in the sample was carried out according to the SNI 6989.8-2009 procedure; SNI 6989.6-2009 and SNI 062462-1991. this procedure involves

1. 50ml of sample was put into 100 ml Erlenmeyer, added 5ml of concentrated HNO_3 then covered with a funnel.
2. It is heated slowly until the remaining volume is 15ml-20ml, if the digestion is not complete (not clear) then add another 5 ml of concentrated HNO_3 then cover and heat again (not boiling) until all the metal dissolves.
3. The levels of the heavy metal were tested by testing the test samples one by one into the Atomic Absorption Spectrophotometer (AAS, Shimadzu AA-6300). AAS device with a wavelength of 283.3 nm. Furthermore, the metal absorption of each metal was carried out.
4. The AAS was calibrated with relevant Shimadzu AAS spectroscopic grade standards. Flame atomic absorption spectrophotometer (Shimadzu double beam Atomic Absorption Spectrophotometer) (Direct determination - Flame: Pb, 0.1ppm; Furnace: Pb, 0.3 ppb).
5. Some heavy metal that would be suspected based on results of other similar study in Rivers State are Manganese, Lead, Cadmium, Iron, Cobalt, Mercury, Zinc, Arsenic Chromium

2.7 Evaluation of Water Quality Index (WQI)

The procedure for evaluation of water quality index based on the physicochemical properties and heavy metals involves the following steps;

1. Calculation of weightage of the parameter W_i . The weightage parameter $W_i = 1/S_i$, Where W_i is the unit weightage and S_i the recommended standard for the parameter,
2. Calculate the quality rating for each of the parameter and heavy metal Q_i . Individual quality rating is given by the expression $Q_i = V_i/S_i$, Where Q_i is the sub index of the parameter, v_i is the monitored value of the parameter and S_i the standard or permissible limit for the parameter.
3. Then water quality index is computed using the following equation

$$\frac{\sum_{i=1}^n W_i Q_i}{\sum_{i=1}^n W_i} \quad (1)$$

2.8 Statistical Analysis Descriptive statistic was used for data analysis. while Analysis of Variance (ANOVA) was used to test hypotheses 1 and 2 respectively, the data analysis was carried out using the X-L Stat package.

3 RESULTS AND DISCUSSION

3.1 Water quality index of the water sampled at different distances from waste dumpsite in the various studies areas

The water quality index (WQI) evaluated for water collected at distances of 100, 150 and 200 meters away from the waste dumpsite based on the concentration of the heavy metals and the physicochemical properties of the water sample sampled within the Aluu, Eneka and Trans-amadi respectively are presented as follows;

3.1.1 Water quality index of the water sampled at different distances from waste dumpsite in the ALuu community

Tables 1 to 3 showed that results of the evaluation of water quality index of the water sampled at distances of the 100, 150 and 2000 meters away from the waste dumpsite in Aluu community. The results revealed that the water quality index at various distances of 100, 150 and 200 were 0.87, 0.71 and 0.63 respectively. Using the WHO (2020) standard for drinking based on water quality index of “0-0.25 is very good water quality for drinking, 0.26-0.50 is good for drinking, 0.51-0.75 is poor and 0.76 and above is not suitable for drinking”, it could be observed that the water sampled from the boreholes within the distances of 100 meters was not suitable for drinking, while water sampled from borehole within 150 and 200 meters were poor for drinking and need little treatment before drinking. However, it could be noticed the quality of water drops (WQI increases) as the distance toward the waste dumpsite reduces. This is an indication that groundwater systems closer to waste dumpsite are easily contaminated by seepage of pollutant into groundwater leading to lower the quality of groundwater,

Table 1 Water quality index of water sampled at distances of 100 meter away from waste dumpsite in Aluu Community

Parameter	Concentration	WHO Standard	W_1	Q_1	$W_1 Q_1$
pH	6.80	7.50	0.133	0.91	0.121
BOD (mg/L)	4.40	5.00	0.20	0.88	0.176
COD (mg/L)	11.20	10.00	0.10	1.12	0.112
Turbidity (NTU)	6.20	5.00	0.20	1.24	0.248
EC (μ S/cm)	1370	1500	0.0007	0.913	0.001
TDS (mg/L)	525	500	0.002	1.05	0.0021

Copper (mg/L)	0.0038	0.020	50	0.001	0.05
Nickel (mg/L)	0.017	0.020	50	0.85	42.50
Cadmium (mg/L)	0.018	0.050	20	0.36	7.20
Chromium (mg/L)	0.0028	0.003	333.3	0.93	309.97
Zinc (mg/L)	0.039	3.000	0.333	0.013	0.004
Lead (mg/L)	0.0126	0.010	100	1.26	126
Iron (mg/L)	0.0155	0.300	3.33	0.052	0.173
$\sum w_i = 557.61$				$\sum W_1 Q_{1i} = 486.55$	

$$WQI = \frac{\sum W_1 Q_{1i}}{\sum w_i} = \frac{486.55}{557.61} = 0.87$$

Table 2 Water quality index of water sampled at distances of 150 meter away from waste dumpsite in Aluu Community

Parameter	Concentration	WHO Standard	W_1	Q_1	$W_1 Q_1$
pH	6.50	7.50	0.133	0.867	0.115
BOD (mg/L)	3.15	5.00	0.20	0.63	0.126
COD (mg/L)	9.50	10.00	0.10	0.95	0.095
Turbidity (NTU)	4.80	5.00	0.20	0.96	0.192
EC (μ S/cm)	1230	1500	0.0007	0.82	0.0006
TDS (mg/L)	435	500	0.002	0.87	0.002
Copper (mg/L)	0.0031	0.020	50	0.155	7.75
Nickel (mg/L)	0.014	0.020	50	0.70	35
Cadmium (mg/L)	0.013	0.050	20	0.26	5.2
Chromium (mg/L)	0.0022	0.003	333.3	0.73	243.3
Zinc (mg/L)	0.017	3.000	0.333	0.006	0.0019
Lead (mg/L)	0.0105	0.010	100	1.05	105
Iron (mg/L)	0.0125	0.300	3.33	0.041	0.137

$$\sum w_i = 557.61$$

$$\sum W_1 Q_{1i} = 396.9$$

$$WQI = \frac{\sum W_1 Q_{1i}}{\sum w_i} = \frac{396.9}{557.61} = 0.71$$

Table 3 Water quality index (WQI) of water sampled at distances of 200 meter away from waste dumpsite in Aluu Community

Parameter	Concentration	WHO Standard	W_1	Q_1	$W_1 Q_1$
pH	7.10	7.50	0.133	0.946	0.126
BOD (mg/L)	2.90	5.00	0.20	0.58	0.112
COD (mg/L)	7.70	10.00	0.10	0.77	0.077
Turbidity (NTU)	4.10	5.00	0.20	0.82	0.164
EC (μ S/cm)	1185	1500	0.0007	0.79	0.00055
TDS (mg/L)	403	500	0.002	0.81	0.0016
Copper (mg/L)	0.0024	0.020	50	0.12	6.00
Nickel (mg/L)	0.011	0.020	50	0.55	27.5
Cadmium (mg/L)	0.0080	0.050	20	0.16	3.20
Chromium (mg/L)	0.0020	0.003	333.3	0.667	222.31
Zinc (mg/L)	0.0120	3.000	0.333	0.004	0.326
Lead (mg/L)	0.0095	0.010	100	0.95	95
Iron (mg/L)	0.0065	0.300	3.33	0.021	0.07
			$\sum w_i = 557.61$	$\sum W_1 Q_{1i} = 351.69$	

$$WQI = \frac{\sum W_1 Q_{1i}}{\sum w_i} = \frac{351.69}{557.61} = 0.63$$

3.1.2 Water quality index of the water sampled at different distances from waste dumpsite in the Eneka community

Tables 4 to 6 showed that results of the evaluation of water quality index of the water sampled at distances of the 100, 150 and 2000 meters away from the waste dumpsite in Eneka community. The results revealed that the water quality index at various distances of 100, 150 and 200 were 1.05, 0.87 and 0.46 respectively Using the WHO (2020)

standard for drinking based on water quality index of 0-0.25 is very good water quality for drinking, 0.26-0.50 is good for drinking, 0.51-0.75 is poor and 0.76 and above is not suitable for drinking”, it could be observed that the water sampled from the boreholes within the distances of 100 and 150 meters were not suitable for drinking while water sampled at distance of 200m was good for drinking. However, it could be noticed the quality of water decreases (WQI increases) as the distance toward the waste dumpsite reduces. This is also a clear indication that groundwater systems closer to waste dumpsite are easily contaminated by seepage of pollutant into groundwater leading to lower the quality of groundwater,

Table 4 Water quality index of water sampled at distances of 100 meter away from waste dumpsite in Eneka Community

Parameter	Concentration	WHO Standard	W_1	Q_1	W_1Q_1
pH	7.40	7.50	0.133	0.99	0.132
BOD (mg/L)	5.40	5.00	0.20	1.08	0.22
COD (mg/L)	12.20	10.00	0.10	1.22	0.12
Turbidity (NTU)	5.70	5.00	0.20	1.14	0.23
EC (μ S/cm)	1240	1500	0.0007	0.83	0.0005
TDS (mg/L)	576	500	0.002	1.15	0.002
Copper (mg/L)	0.018	0.020	50	0.90	45
Nickel (mg/L)	0.017	0.020	50	0.85	42.5
Cadmium (mg/L)	0.048	0.050	20	0.96	19.2
Chromium (mg/L)	0.0028	0.003	333.3	0.93	309.97
Zinc (mg/L)	0.750	3.000	0.333	0.25	0.083
Lead (mg/L)	0.0165	0.010	100	1.65	165
Iron (mg/L)	0.255	0.300	3.33	0.85	2.83
			$\sum w_i = 557.61$		$\sum W_1Q_{1i} = 585.29$

$$WQI = \frac{\sum W_1Q_{1i}}{\sum w_i} = \frac{585.29}{557.61} = 1.05$$

Table 5 Water quality index of water sampled at distances of 150 meter away from waste dumpsite in Eneka Community

Parameter	Concentration	WHO Standard	W_1	Q_1	W_1Q_1
pH	6.30	7.50	0.133	0.84	0.11
BOD (mg/L)	5.15	5.00	0.20	1.03	0.21
COD (mg/L)	10.30	10.00	0.10	1.03	0.103
Turbidity (NTU)	4.90	5.00	0.20	0.98	0.196
EC (μ S/cm)	1190	1500	0.0007	0.79	0.006
TDS (mg/L)	520	500	0.002	1.04	0.002
Copper (mg/L)	0.015	0.020	50	0.75	37.50
Nickel (mg/L)	0.014	0.020	50	0.70	35
Cadmium (mg/L)	0.039	0.050	20	0.78	15.60
Chromium (mg/L)	0.0022	0.003	333.3	0.73	243.3
Zinc (mg/L)	0.417	3.000	0.333	0.139	0.05
Lead (mg/L)	0.015	0.010	100	1.50	150
Iron (mg/L)	0.225	0.300	3.33	0.75	2.50
$\sum w_i = 557.61$				$\sum W_1Q_{1i} = 484.78$	

$$WQI = \frac{\sum W_1Q_{1i}}{\sum w_i} = \frac{484.78}{557.61} = 0.87$$

Table 6 Water quality index (WQI) of water sampled at distances of 200 meter away from waste dumpsite in Eneka Community

Parameter	Concentration	WHO Standard	W_1	Q_1	W_1Q_1
pH	7.30	7.50	0.133	0.97	0.129
BOD (mg/L)	4.30	5.00	0.20	0.86	0.172
COD (mg/L)	9.30	10.00	0.10	0.93	0.093
Turbidity (NTU)	4.30	5.00	0.20	0.86	0.172

EC (μS/cm)	1155	1500	0.0007	0.77	0.001
TDS (mg/L)	475	500	0.002	0.95	0.002
Copper (mg/L)	0.014	0.020	50	0.70	35.00
Nickel (mg/L)	0.011	0.020	50	0.55	27.50
Cadmium (mg/L)	0.028	0.050	20	0.56	11.20
Chromium (mg/L)	0.0015	0.003	333.3	0.50	166.65
Zinc (mg/L)	0.129	3.000	0.333	0.043	0.014
Lead (mg/L)	0.0015	0.010	100	0.15	15
Iron (mg/L)	0.165	0.300	3.33	0.55	1.83
$\sum w_i = 557.61$				$\sum W_1 Q_{1i} = 257.76$	

$$WQI = \frac{\sum W_1 Q_{1i}}{\sum w_i} = \frac{257.76}{557.61} = 0.46$$

2.1.3 Water quality index of the water sampled at different distances from waste dumpsite in the Trans-amadi community

Tables 7 to 9 showed that results of the evaluation of water quality index of the water sampled at distances of the 100, 150 and 2000 meters away from the waste dumpsite in Trans-amadi community. The results revealed that the water quality index at various distances of 100, 150 and 200 were 1.01, 0.96 and 0.75 respectively. Using the WHO (2020) standard for drinking based on water quality index of “0-0.25 is very good water quality for drinking, 0.26-0.50 is good for drinking, 0.51-0.75 is poor and 0.76 and above is not suitable for drinking”, it could be observed that the water sampled from the boreholes within the distances of 100 and 150 meters were not suitable for drinking while water sampled at distance of 200m was poor for drinking. However, it could also be noticed that the quality of water decreases (WQI increases) as the distance toward the waste dumpsite reduces. This is also a clear indication that groundwater systems closer to waste dumpsite are easily contaminated by seepage of pollutant into groundwater leading to lower the quality of groundwater,

Table 7 Water quality index of water sampled at distances of 100 meter away from waste dumpsite in Trans-amadi Community

Parameter	Concentration	WHO Standard	W_1	Q_1	$W_1 Q_1$
pH	6.70	7.50	0.133	0.89	0.118
BOD (mg/L)	5.70	5.00	0.20	1.14	0.23

COD (mg/L)	13.50	10.00	0.10	1.35	0.135
Turbidity (NTU)	5.20	5.00	0.20	1.05	0.21
EC (μS/cm)	1430	1500	0.0007	0.95	0.00066
TDS (mg/L)	576	500	0.002	1.152	0.002
Copper (mg/L)	0.025	0.020	50	1.25	62.50
Nickel (mg/L)	0.018	0.020	50	0.90	40.0
Cadmium (mg/L)	0.053	0.050	20	1.06	21.2
Chromium (mg/L)	0.0028	0.003	333.3	0.93	309.97
Zinc (mg/L)	0.950	3.000	0.333	0.317	0.11
Lead (mg/L)	0.0125	0.010	100	1.25	125
Iron (mg/L)	0.295	0.300	3.33	0.98	3.26
$\sum w_i = 557.61$				$\sum W_1 Q_{1i} = 562.68$	

$$WQI = \frac{\sum W_1 Q_{1i}}{\sum w_i} = \frac{562.68}{557.61} = 1.01$$

Table 8 Water quality index of water sampled at distances of 150 meter away from waste dumpsite in Trans-amadi Community

Parameter	Concentration	WHO Standard	W_1	Q_1	$W_1 Q_1$
pH	6.60	7.50	0.133	0.88	0.117
BOD (mg/L)	5.25	5.00	0.20	1.05	0.21
COD (mg/L)	11.30	10.00	0.10	1.13	0.113
Turbidity (NTU)	4.60	5.00	0.20	0.92	0.184
EC (μS/cm)	1310	1500	0.0007	0.87	0.00061
TDS (mg/L)	520	500	0.002	1.04	0.0021
Copper (mg/L)	0.025	0.020	50	1.25	62.50
Nickel (mg/L)	0.015	0.020	50	0.75	37.5
Cadmium (mg/L)	0.045	0.050	20	0.90	18

Chromium (mg/L)	0.0022	0.003	333.3	0.73	243.31
Zinc (mg/L)	0.717	3.000	0.333	0.239	0.079
Lead (mg/L)	0.017	0.010	100	1.70	170
Iron (mg/L)	0.275	0.300	3.33	0.92	3.06
$\sum w_i = 557.61$				$\sum W_1 Q_{1i} = 535.08$	

$$WQI = \frac{\sum W_1 Q_{1i}}{\sum w_i} = \frac{535.08}{557.61} = 0.96$$

Table 9 Water quality index (WQI) of water sampled at distances of 200 meter away from waste dumpsite in Trans-amadi Community

Parameter	Concentration	WHO Standard	W_1	Q_1	$W_1 Q_1$
pH	7.40	7.50	0.133	0.99	0.132
BOD (mg/L)	5.10	5.00	0.20	1.02	0.204
COD (mg/L)	10.30	10.00	0.10	1.03	0.103
Turbidity (NTU)	4.60	5.00	0.20	0.92	0.184
EC (μ S/cm)	1235	1500	0.0007	0.82	0.00057
TDS (mg/L)	475	500	0.002	0.95	0.0019
Copper (mg/L)	0.015	0.020	50	0.75	37.5
Nickel (mg/L)	0.014	0.020	50	0.70	35
Cadmium (mg/L)	0.038	0.050	20	0.76	15.2
Chromium (mg/L)	0.0015	0.003	333.3	0.50	166.65
Zinc (mg/L)	0.629	3.000	0.333	0.210	0.069
Lead (mg/L)	0.015	0.010	100	1.50	150
Iron (mg/L)	0.215	0.300	3.33	0.717	2.39
$\sum w_i = 557.61$				$\sum W_1 Q_{1i} = 407.43$	

$$WQI = \frac{\sum W_i Q_{1i}}{\sum W_i} = \frac{407.43}{557.61} = 0.73$$

These results did not agree with study by Yerima Kwaya et al., (2019) carried out investigation on the groundwater quality of Maru town and environs in terms of Heavy metals concentration using the pollution indices and multivariate statistical approaches. They used twenty-nine groundwater samples taken from dug wells and one Borehole in the area and analyzed for the presence of Heavy metals, Temperature and PH. The concentration of the analyzed metals in the groundwater arranged in decreasing order is Cr > Fe > Mn > Zn > Cu > Ni with three elements Cr, Fe and Mn had concentrations above the WHO recommended limits. Calculated Pollution indices revealed that HPI gave an overall high value, consequently translating the area as high groundwater pollution zones.

3.2 Hypotheses testing

The presented of the results on the hypotheses testing is shown below:

H₀₁: There is no significant difference in the concentrations of the water parameters in the water samples collected from the three sampled locations

Table 10 shows the summary of ANOVA analyses carried out to examine whether there is statistically significant difference in the concentration of water parameters obtained at distances of 100, 150 and 200 meters from the three sampled areas. The results revealed that there is no statistically significant difference in concentration of water pollutant parameters for water sampled at distance of 100m, 150 and 200 from the three areas with p-values of 0.773, 0.135 and 0.675 which is greater than 0.05 significance level. Hence the null hypothesis which states that “There is no significant difference in the concentrations of the water parameters in the water samples collected from the three sampled locations” is accepted while the alternate hypothesis is rejected. This means that there is similar trend of groundwater contamination around waste dumpsites in Port Harcourt

Table 10. Summary of ANOVA analysis for Hypothesis One

Water Parameter differential	F-value	P-value
Distance 100	0.953	0.773
Distance 150	1.035	0.135
Distance 200	0.834	0.675

H₀₂: There is no significant difference in the WQI of the water samples from the three sampled locations

Table 11 shows the summary of ANOVA analyses carried out to examine whether there is statistically significant difference in the WQI of the water samples from the three

sampled locations obtained at distances of 100, 150 and 200 meters from the three sampled areas. The results revealed that there is no statistically significant difference in WQI of water sampled at distance of 100m, 150 and 200 from the three areas with p-values of 0.063, 0.143 and 0.075 which is greater than 0.05 significance level. Hence the null hypothesis which states that “There is no significant difference in the WQI of the water samples from the three sampled locations” is accepted while the alternate hypothesis is rejected. This means that there is similar trend of water quality index around waste dumpsites in Port Harcourt

Table 11 Summary of ANOVA analysis for Hypothesis two

Water quality Index differential	F-value	P-value
Distance 100	1.653	0.063
Distance 150	1.235	0.143
Distance 200	1.540	0.075

4 Conclusions

The assessment of quality index of groundwater around waste dump-site in River State has been carried out. Based on the findings of the study, it was concluded that; water quality index of the groundwater around waste dumpsites is dependent on the distance of the dumpsite from the location of the water source such that the closer that water source to the dumpsite, the lower the quality of the water due to increased seepage of pollutant from the dumpsite in to the groundwater system. It was also concluded that, there is no significant difference in both concentration of water quality parameters and water quality index for water sampled at same distance from dumpsite in the three communities sampled for the study which shows similarly in underground formation geology and geophysics as well as similarity in dumpsite design in the state.

REFERENCES

- Adeyemi O.S & Awokunmi E.E (2016). The impact of municipal solid waste disposal in Ado-Ekiti metropolis, Ekiti State, Nigeria. *African Journal of Environmental Science and Technology*. 3(8): 186-191.
- Bunce N.J (2014) Environmental Chemistry. *2nd ed., Canada: Wuevz Publishing Ltd. Wininnipeg*, 20-25.
- Famiglietti, J. S. (2014). The global groundwater crisis. *Nature Climate Change*. 4 (11), 945–948
- Nwoke I.B & Edori E.S (2020). Concentration of heavy metals in borehole water from Ikono Urban, Ikono Local Government Area, Akwa Ibom State, Nigeria. *International Journal of Advanced Research in Chemical Sciences*. 7(1): 27-33.

- Nwoke IB & Edori ES (2021) Levels of some chemical species in water of boreholes situated near dumpsites in Rumuolumeni, Port Harcourt, Rivers State, Nigeria, *World Journal of Advanced Research and Reviews*, 12(02), 202–211
- Owabor C.N, Ogbeide SE & Susu AA (2010) Estimation of transport and degradation parameters for Naphthalene and Anthracene: influence of mass transfer on kinetics. *Environmental Monitoring and Assessment* 169(34): 607-617.
- Umo A.E & Okoye C.O.B (2016) Quality of Borehole Waters in Nsukka Area, Enugu State Nigeria. *Nigeria Annals of Natural Sciences* 6(4) 121-123.
- WHO (2017) International Standards for Drinking Water (8th ed.) *Geneva*, 36-38.
- Yerima Kwaya M. Hamidu H, Ibrahim M. A Nura A Habib A Muhammed G. H Dauda M, Bello H Mohammad K. H (2019). Heavy Metals Pollution Indices and Multivariate Statistical Evaluation of Groundwater Quality of Maru town and environs, *Journal of Materials and Environmental Sciences* 10 (1),32-44